VIII. JURASSIC INSECTS FROM SOLENHOFEN IN THE CARNEGIE MUSEUM AND THE MUSEUM OF COMPARATIVE ZOÖLOGY.

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The lithographic limestone at Solenhofen, Bavaria, and vicinity, has long been famous as a source of Jurassic fossils. Although the reputation of the formation has depended largely upon the discovery of certain remarkable vertebrates, such as *Archæopteryx* and *Rhamphorhynchus*, invertebrates are far commoner. Most of these are marine types, the limestone being marine in its origin; but numerous insects, which undoubtedly fell into the water, have also been preserved. More publications have been devoted to these insects than to any other fossil insect-fauna of equivalent size, chiefly because the commercial working of the limestone has produced an almost continuous output of specimens.

In view of the extensive bibliography of the fossil insects of Solenhofen, one might conclude that all positive information about them has already been published. This would probably be true, were it not for the fact that, exclusive of Handlirsch's extensive compilation on fossil insects (1906-08), and a few papers of a general nature, or brief notes, all the literature was published prior to 1900, before the geological history of the insects as a whole was well enough known to enable a proper appreciation of the species contained in any one stratum. Handlirsch, of course, straightened out most of the taxonomic difficulties encountered by the older investigators, and was able to make the necessary comparisons with other extinct faunas; but he was not able to examine specimens of all the species from Solenhofen, and, with a few exceptions, took his figures without modification from the earlier writings.

Several years ago, while engaged in a rearrangement of the fossil insects in the Museum of Comparative Zoölogy, I was impressed by the large number of specimens from Solenhofen in that collection. Studies on other fossil insects already in progress prevented my immediate examination of these, but last year my attention was called

to another large collection in the Carnegie Museum. This material, although secured many years ago from Baron de Bayet,* the Private Secretary of King Leopold II of Belgium, when he sold his vast collection to Mr. Andrew Carnegie, had not been critically studied until 1930, when Mr. Stephen Herrick, a graduate student in the University of Pittsburgh, undertook its arrangement and description. Mr. Herrick, however, did not proceed far, and did not prepare any account for publication. Accordingly the entire collection was sent to me for detailed description. This is particularly desirable, not only because the Bayet Collection contains new material, but because the percentage of excellent specimens in it is unusually high. The present paper is essentially an annotated list of the specimens in the collection of the Carnegie Museum. I have, however, considered it opportune to mention and occasionally describe some of the important fossils in the Museum of Comparative Zoölogy. About half of the Harvard collection was secured from Krantz as far back as 1860, and was studied by Hagen; but many of the specimens have not been properly described.[1] The other half of the collection was purchased from Haberlein about 1883; it has not been studied, or at least published upon, except very briefly.[2] For the benefit of those who desire further discussion of the fossils of Solenhofen, I have included under each species the reference to the original description and to the important subsequent redescriptions; a more complete series of references will be found in Handlirsch (1906-08). In the bibliography I have listed the most useful papers on the fauna. The synonymy of these fossils is very confusing and uncertain. In the main I have followed Handlirsch, but I believe that he recognizes many more species than are actually valid. This is chiefly due to the inadequacy of the figures and descriptions published during the Eighteenth and early

*The Editor, who acted as the agent of Mr. Andrew Carnegie in the purchase of the Collection of Baron de Bayet, and spent many weeks in Brussels in 1908 packing it for shipment to Pittsburgh, recalls that the Baron informed him that the specimens from Solenhofen had been acquired at the quarries from the superintendents to whom the Baron had made an offer to recompense them for all fossils found by them in good condition as they proceeded with their work. This offer continued for a couple of years and it was thus that Baron de Bayet succeeded in amassing among other things the fine collection of insects from Solenhofen. W. J. H.

[1]One of these I have already described in *Psyche*, Vol. XXXVI; No. 3, pp. 190-194, 1929.

[2]See Tillyard, 1921, 1927; Needham, 1903, 1907.

Nineteenth Centuries. The authors of these accounts often made a new species for every specimen preserved in a different position.

It is surprising, that, although the shales of Solenhofen were used for building purposes in the time of the Roman Empire, no recognizable accounts of fossils were published, so far as I am aware, until 1705, when Rumphius described a fish from the formation. Knorr (1755) was the first to mention the presence of insects; in 1782 Schmidel figured a dragon-fly from the limestone; two years later Schröter published a description of a supposed Sphingid, which is now known to be a Siricoid wasp. During the first third of the Nineteenth Century a few isolated accounts were published, mostly on Dragonflies (Kœhler, Parkinson, Van der Linden); but after the discovery of lithography in 1834,[3] large collections of the fossils were secured, which were first studied by Germar (1837, 1839, 1842), later by Hagen (1862, 1866, et seq.), and Weyenbergh (1869, 1873, et seq.). Deichmüller (1886) published a very complete account of the lithographic insects in the Dresden Museum; and Handlirsch made a comprehensive compilation and classification of the species (1906).

In the Carnegie Museum there are one hundred and forty-six specimens sufficiently well preserved at least to permit generic classification. In the Museum of Comparative Zoölogy there are two hundred and eighty-six such specimens. In the accompanying table I have listed the percentages of specimens falling into each order. The figures in the first column are based upon the four hundred and thirty-two specimens, which I have examined in these two collections; those in the second column are the percentages which Deichmüller found in his collection of two hundred and seventy-two specimens; and in the last column are the averages of these, based upon the seven hundred and four specimens in all three collections. This last computation probably represents a fairly accurate picture of the relative abundance of the several orders. From this it is apparent that the *Odonata* are far in the lead, followed by the *Hymenoptera*, *Coleoptera*, *Blattaria*, *Hemiptera*, *Orthoptera*, *Phasmodea*, *Plectoptera*, *Neuroptera*, and finally the *Trichoptera*. These figures do not, however, represent the composition of the insect-fauna, which existed in the region of Solenhofen during the Upper Jurassic; for the limestone is of such a nature that only the larger insects were capable of being preserved,

[3]See Crook, A. R., "*The Lithographic Stone Quarries of Bavaria, Germany*," Stone, Oct., 1894.

the smaller ones having been decomposed, or devoured by fishes before fossilization took place.

Table I. Approximate percentages of specimens from Solenhofen in each order of insects.

	Carpenter (432 specimens)	Deichmüller (272 specimens)	Average (704 specimens)
Plectoptera	4. pr. ct.	.3 pr. ct.	2.1 pr. ct.
Odonata	33. pr. ct.	34. pr. ct.	34. pr. ct.
Blattaria	6. pr. ct.	11. pr. ct.	9. pr. ct.
Orthoptera	9. pr .ct.	5. pr. ct.	7. pr. ct.
Phasmodea	8. pr. ct.	5. pr. ct.	7. pr. ct.
Hemiptera	10. pr. ct.	6. pr. ct.	8. pr. ct.
Neuroptera	2. pr. ct.	1. pr. ct.	1.5 pr. ct.
Trichoptera	.2 pr. ct.	.... pr. ct.	.1 pr. ct.
Coleoptera	13. pr. ct.	12. pr. ct.	13. pr. ct.
Hymenoptera	12. pr. ct.	24. pr. ct.	18. pr. ct.

Order **PLECTOPTERA.**

The May-flies of Solenhofen, although few in number, are particularly interesting, since they are the first representatives of members of the order in rocks above the Permian. Aside from a few fragments from the Lower Cretaceous of Mongolia (Cockerell, 1924, 1927) they are the only Ephemerids known in the whole Mesozoic. However, because of the delicacy of the wings and their tendency to fold together in such a way that the venation is badly confused, good specimens of these fossils are extremely rare. Thirteen species of May-flies from Solenhofen have been described, but many of these are undoubtedly synonymous. Handlirsch has separated most of these species into two genera, *Mesephemera* and *Paedephemera*, the former including species with nearly homonomous wings, and the latter species with the hind wings more reduced in size, about two-thirds the length of the fore wings. Although the general shape of the wings is known in *Mesephemera*, the details of the venation have not been determined. But in *Paedephemera* the venation is known in two species, *multinervosa* Oppenheim, and *schwertschlageri* Handlirsch. The latter, which was based upon a fine specimen, is in all probability synonymous with one of the other species of the genus, but in view of the obscurity of these other species, I believe we should retain a separate name for Handlirsch's specimen. The single remaining genus,

Hexagenites Scudder is probably synonymous with *Mesephemera*, but because the hind wing is unknown and for another reason given below, I believe Scudder's genus should be regarded as valid.

Inasmuch as the existing Ephemerids have now been divided into recent families, I propose the name *Mesephemeridæ* for these forms from Solenhofen. At present, because of our lack of knowledge of their tarsal and other body-structures, I do not believe we can assign them to existing families or even superfamilies.

Family MESEPHEMERIDÆ.

Genus MESEPHEMERA Handlirsch.

1. **Mesephemera procera** (Hagen).

Ephemera procera Hagen, 1862, Palæontogr., X, 116; pl. 15, f. 2.
Mesephemera procera Handlirsch, 1906, Foss. Ins.: 600.

I consider *speciosa* Oppenheim (1888) and *weyenberghi* Handlirsch (1906) as synonyms of this species. *Lithophila* Germar (1842) is probably the same insect also, although it was considered by its author to be a Lepidopteron; but Germar's figure and descriptions do not serve as sufficient identification of the species. In the Bayet Collection in the Carnegie Museum there are five specimens of *M. procera*; Nos. 3835, 3836–3837,* 3838–3839, 5083–5084, 5085–5086. In the Museum of Comparative Zoölogy there are four specimens, of which one (No. 6280a, b) is marked "type" by Krantz. In none of these is the venation distinct, and I can add nothing to Hagen's description.

2. **Mesephemera cellulosa** (Hagen).

Ephemera cellulosa Hagen, 1862, Palæontogr., X, 115; pl. 15, f. 3.
Mesephemera cellulosa Handlirsch, 1906, Foss. Ins.: 601.

In the Bayet Collection (Carn. Mus.) there are two specimens: Nos. 3840 and 5087. In the Museum of Comparative Zoölogy there are four specimens, one (No. 6281a, b) being the type figured by Hagen.

*In this paper all the figures connected with a dash indicate the reverse of the first numbered specimens.

Genus PAEDEPHEMERA Handlirsch.

3. **Paedephemera mortua** (Hagen).

Ephemera mortua Hagen, 1862, Palæontogr., X, 117; pl. 15, f. 5.
Paedephemera mortua Handlirsch, 1906, Foss. Ins.: 602.

I consider Handlirsch's *oppenheimi* a synonym of this species. There are no representatives in the Bayet Collection of the Carnegie Museum, but in the Museum of Comparative Zoölogy, there is the type figured by Hagen (No. 6283).

Genus HEXAGENITES Scudder.

4. **Hexagenites weyenberghi** Scudder. (Fig. 1)

Ephemerida, Eaton, 1871, Trans. Ent. Soc. Lond., p. 158; pl. 1, f. 10.
Hexagenites weyenberghi Scudder, 1880, Anniv. Mem. Bost. Soc. Nat. Hist., 6.

Length of fore wing, 15 mm.

Scudder's description of this fossil was based entirely upon Eaton's published figure of a specimen in the British Museum. In the Museum of Comparative Zoölogy I find a very fine specimen of a May-fly, to which is attached the following note, in Hagen's characteristic writing: "*Ephemera cellulosa* Hagen, front wings and outline of body and setæ." On the reverse side of this label, written in a hand unfamiliar to me, is the following: "The counterpart was described by Scudder as *Palin. Weyenberghi.*" Although this note is incorrect in its reference to the genus in which Scudder placed the species, there can be no doubt that this fossil (No. 6277) in the Museum of Comparative Zoölogy is the reverse of the specimen examined by Eaton in the British Museum. A comparison of the venation of our

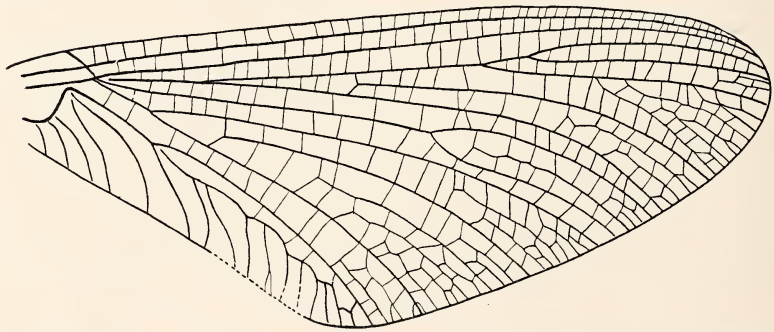

FIG. 1. *Hexagenites weyenberghi* Scudder, fore wing. Type (No. 6277), Mus. Comp. Zoöl. Magnified.

fossil and the figure given by Eaton shows that not only do all the cross-veins and cells correspond, but also the various breaks and imperfections in the wing occur in the same places, although our half of the fossil has been chipped out of the matrix, so that the whole wing is exposed. The specimen before me is therefore the counterpart of the type of Scudder's *weyenberghi*. Hagen's determination of this species as *cellulosa* perhaps indicates that *weyenberghi* is synonymous with *cellulosa*; but in view of the fact that *cellulosa* is a very obscure species, and is closely involved with the synonymy of the several species of *Mesephemera*, I believe that *weyenberghi* should be regarded as a separate species of a distinct genus. Figure 1, showing the fore wing of this May-fly, is based on the specimen in the Museum of Comparative Zoölogy. The entire wing is preserved with remarkable clearness. This is the only known complete wing of a Mesozoic May-fly. The figure shows more clearly than can be depicted in words the characteristics of the wing, but I wish to call attention to the similarity of this wing to that of recent May-flies, even to the formation of the third auxiliary vein at the base of the wing (3 *Ax*). The triad forking of *CuA* and the peculiar branching of *ICuA* are very distinctive features. As Scudder pointed out, the nearest approach to this *CuA* is found in the recent genus *Hexagenia*.

Order **ODONATA.**

As previously noted, the *Odonata* are the commonest insects in the shales of Solenhofen and they are usually well preserved. This fact, together with the importance of venational features in classifying the members of the order, has made the species of Solenhofen particularly valuable in studies of the evolution of the order. Unlike the May-flies, the dragon-flies are well represented in the Mesozoic strata. The Triassic of Australia, Liassic of England and Germany, and the Upper Jurassic of Turkestan have contributed many fossils of this order. The beds of Solenhofen, however, are the oldest rocks to yield fossils of the *Anisoptera*, which is now the predominant suborder. The *Zygoptera* are known as far back as the Upper Permian; and the *Anisozygoptera* from the Triassic to the Upper Jurassic and perhaps the Tertiary.[4]

[4]Some students of the *Odonata* consider that the recent Japanese *Epiophlebia* is a member of the *Anisozygoptera*. For an account of this subject, see my discussion in the American Journal of Science, (Ser. 5), Vol. XXXI, p. 97-139, 1931.

Probably the best and most reliable original work on the *Odonata* of Solenhofen has been done by Hagen, who accumulated a large personal collection of the Jurassic dragon-flies, many of which were subsequently given to the Museum of Comparative Zoölogy. Deichmüller described some additional species and contributed a great deal to our knowledge of the venation of Hagen's species; Handlirsch, of course, has given a more modern classification of them. Although about fifty species of *Odonata* have been described from the shales of Solenhofen; more than half of them are synonyms.

SUBORDER *ANISOZYGOPTERA*.

This suborder was established by Handlirsch to include a series of forms ancestral to the true *Anisoptera*. As more and more fossil *Odonata* are found, it is becoming increasingly difficult to draw the boundary between these two suborders. Tillyard has pointed out that Handlirsch included two distinct types of families in the *Anisozygoptera*: one in which the discoidal cell of the hind wing is radically different from that of the fore wing (more specialized); and another, in which the discoidal cell of the fore wing has finally attained the degree of specialization reached by that of the hind wing. He has suggested that the former series be included in the *Anisozygoptera*, and the latter in the *Anisoptera*. This view I was also led to accept from my review of the Permian species (1931). According to this use of the subordinal name, the family *Stenophlebiidæ* from Solenhofen becomes a member of the *Anisoptera*, instead of the *Anisozygoptera*, where it was placed by Handlirsch.

Family TARSOPHLEBIIDÆ.

Genus TARSOPHLEBIA Hagen.

5. **Tarsophlebia eximia** (Hagen). (Fig. 2)

Heterophlebia eximia Hagen, 1862, Palæontogr., X, 106.
Tarsophlebia eximia Hagen, 1866, Palæontogr., XV, 65; pl. 1, f. 1-6, 11.

Length of fore wing, 30–36 mm.

This is not a common species in the limestone and was undoubtedly a delicate species, for the specimens are not nearly so well preserved as the other *Odonata*. It is one of the most interesting of all the species in the formation, however, because of the simple structure of the discoidal cell, which is open (or really absent) in at least the fore wing. The hind wing was figured by Hagen as having a similar structure,

and that view has been generally accepted; but in no specimen which I have seen, including Hagen's types, are the hind wings sufficiently well preserved to convince me that this was actually the case. The venation has been figured by Hagen and his drawing has been reproduced in several of Handlirsch's works; but I have included a new figure of the basal part of the wing, showing the peculiar structure of the arculus, which distinguishes *Tarsophlebia* at once from the other genera of Solenhofen. The oblique vein joining the media with *CuP* at the base is obviously a cross-vein or a derivative of a cross-vein, for it is much thinner and weaker than the stem of *MA* or *Rs*.

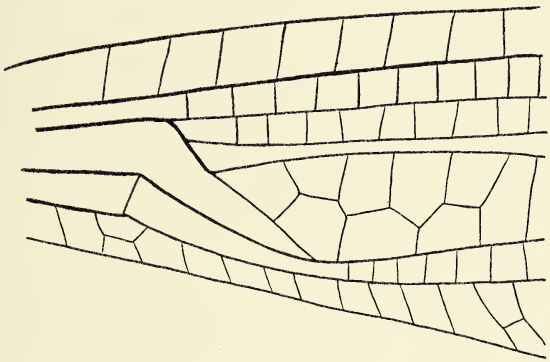

FIG. 2. *Tarsophlebia eximia* (Hagen), base of fore wing. Type (No. 6223), Mus. Comp. Zoöl. Greatly magnified.

In the Bayet Collection of the Carnegie Museum there are four specimens of *eximia*, Nos. 3807, 3808, 5089, 5090, and No. 3828 from the collection received from the Paleontological Museum of Bavaria, Munich, of which the last is very good, although unusually small. In the Museum of Comparative Zoölogy there are twenty-one specimens, Nos. 6216–6227 being a part of the type-series of Hagen.

Family ISOPHLEBIIDÆ.

Genus ISOPHLEBIA Hagen.

6. **Isophlebia aspasia** Hagen.

Isophlebia aspasia Hagen, 1866, Palæontogr., XV, 70; pl. 2, f. 12; pl. 4, f. 13. Deichmüller, 1866, Mitt. Kœnigl. Mineral.-Geol. Præhist. Mus. Dresd., VII, 56; pl. 4, f. 4-6.

Length of fore wing, 95–100 mm.

This is the largest of the dragon-flies of Solenhofen. It is distinguished from the other genera by the quadrilateral shape of the

discoidal cell in the fore wing; I believe that in the hind wing this cell is divided by an oblique cross-vein, forming a triangle; but unfortunately in all of the specimens which I have examined the wings overlap in such a way that one cannot be sure of the presence of the cross-vein. In the Bayet Collection of the Carnegie Museum, there are six specimens of *aspasia*, Nos. 3811, 3812, 3813–3814, 5091, 5092, 5093. In the Museum of Comparative Zoölogy there are twelve specimens, of which Nos. 6186–6189 are Hagen's types.

SUBORDER *ANISOPTERA*.

Family STENOPHLEBIIDÆ.

Genus STENOPHLEBIA Hagen.

7. **Stenophlebia latreillei** (Germar). (Fig. 3)

Agrion latreillei Germar, 1839, Verh. L. Car. Ak., XIX, 218; pl. 23, f. 16.
Stenophlebia æqualis Hagen, 1866, Palæontogr., XV, 86; pl. 1, f. 24.
Stenophlebia latreillei Deichmüller, 1886, Mitt. Kœnigl. Mineral.-Geol. Præhist. Mus., Dresd., VII, 44; pl. 4, f. 13.

Length of fore wing, 50–60 mm.

This slender-winged dragon-fly is characterized by a simple type of discoidal cell, which is similar in structure in both pairs of wings. Hagen and Deichmüller have given good figures, but I include a more detailed drawing of the base of the wing. The arculus is very clearly shown in one specimen (Carnegie No. 3996). The media is more detached from R at the base than it is in any of the *Odonata*, which I

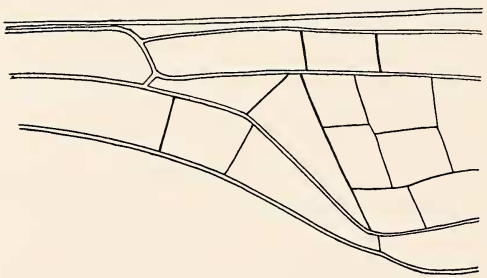

FIG. 3. *Stenophlebia latreillei* (Germar), diagram of main veins at base of fore wing. No. 3796, Carn. Mus.

have seen, and its course at the arculus is very clear. The vein dividing the discoidal cell is much weaker than the longitudinal veins and has the appearance of a cross-vein. In the Bayet Collection of the

Carnegie Museum there are ten specimens of this species (Nos. 3796, 3997, 5094, 5095, 5096–5097, 5098–5099, 5100, 5101–5102 and 3798. No. 3798 from the collection of the Paleontological Museum of Bavaria in Munich). In the Museum of Comparative Zoölogy there are sixteen specimens, of which Nos. 6205, 6210, 6211, 6212, 6213, 6214, 6215 are types of Hagen's synonymous species, *æqualis*, *lithophila*, and *phryne*.

8. **Stenophlebia amphitrite** (Hagen).

Heterophlebia amphitrite Hagen, 1862, Palæontogr., X, 105.
Stenophlebia amphitrite Hagen, 1886, Palæontogr., XV, 83; pl. 3, f. 1.

Length of fore wing, 80 mm.

This species is similar to *latreillei*, but is larger, and has narrower wings with a broader discoidal cell. It is a rare species, and only two specimens are in the Museum of Comparative Zoölogy.

Family ÆSCHNIDÆ.

SUBFAMILY ÆSCHNIDINÆ.[5]

This subfamily includes the most highly specialized of the Jurassic *Odonata* and is related to several recent groups of the family. It was originally established by Handlirsch to include *Æschnidium* Westwood and *Urogomphus* Handlirsch. The former genus was based on fragments of a species (*bubas* Westwood) from the Jurassic of England, but Handlirsch also placed here a second species from the English Jurassic (*antiquum* Brodie), one finely preserved species from the lithographic limestone (*densum* Hagen), and one species from the Cretaceous of Australia (*flindersiensis* Woodward). The latter was placed by Tillyard (1917) in a separate genus *Æschnidiopsis*. In *Urogomphus* Handlirsch placed three species from the lithographic limestone (*giganteus* Hagen, *eximius* Hagen, and *abscissus* Hagen), none of which were represented by species showing details of structure. Now in the Bayet Collection there is a very fine specimen of *giganteus*, showing the minute structure of both pairs of wings. The wings of this fossil turn out to be very close to those of *Æschnidium densum*

[5]As Tillyard has pointed out, if we use the long-established classification of the *Anisoptera*, dividing them into two families, *Æschnidæ* and *Libellulidæ*, then Handlirsch's *Æschnididæ* deserve only subfamily rank. This is the arrangement I have used here.

Hagen, also from the limestone of Solenhofen; in fact these species are so close, that it is obvious they belong to the same genus. However, instead of placing these three species of *Urogomphus* in *Æschnidium* (thus synonymizing *Urogomphus* with *Æschnidium*), I believe it is more satisfactory to transfer the species *densum* from *Æschnidium* to *Urogomphus*. By so doing we include the species from England (*bubas* and *antiquum*) in *Æschnidium*, and all the species from Solenhofen in *Urogomphus*; and there can be no question that these species from Solenhofen are more closely related to each other, than to the English forms. According to this arrangement the subfamily *Æschnidinæ* includes the following:

Æschnidium Westwood (1854). Jurassic of England.
bubas Westwood, *genotype*.
antiquum Brodie.

Æschnidiopsis Tillyard (1917). Cretaceous of Australia.
flindersiensis (Woodward), *genotype*.

Urogomphus Handlirsch (1906). Jurassic of Bavaria.
giganteus (Germar), *genotype*.
eximius (Hagen).
abscissius (Hagen).
densus (Hagen).

9. **Urogomphus giganteus** (Germar). (Fig. 4)

Æschna gigantea Germar, 1839, Nova Acta, XIX, 216; pl. 22, fig. 14.
Estemoa gigantea Deichmüller, 1886, Mitt. Kœnigl. Mineral.-Geol. Præhist. Mus. Dresd., VII, 35; pl. 3, f. 1-3.
Urogomphus giganteus Handlirsch, 1906, Foss. Ins., 594; pl. 47, f. 18.

Length of fore wing, 90–95 mm.

This rare species has previously been known only from very poor specimens. The only original figure is that of Deichmüller, who was able to determine only the general characteristics of the main longitudinal veins in the apical half of the wing. In the Carnegie Museum there is an excellent specimen of this species, showing all details of the venation, including the cellules, except at the very apex of the fore wing. This fossil provides us with the first complete picture not only of *giganteus*, but of *Urogomphus* as a whole, since none of the species of the genus have been represented by good specimens. The fore wing is narrow basally and pointed apically; the posterior margin

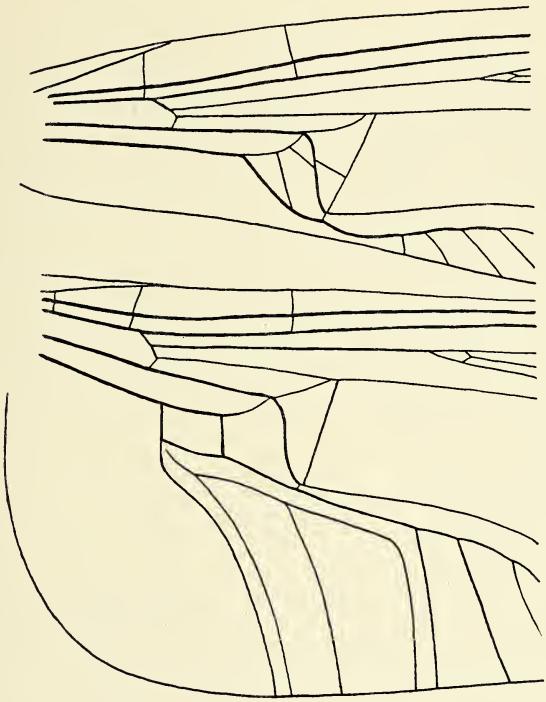

FIG. 4. *Urogomphus giganteus* (Germar), bases of fore and hind wings; specimen No. 3829–3830, Carnegie Museum. The fine network of cross-veins resembling that of *densus* is omitted from the figure. Magnified.

possesses two indentations, one at the termination of R3 and the other at the end of R4; nodus at about midwing; both 1R2 and R3, R4 and M converging at the margin; the two original antenodals very distinct; supratriangle very long and narrow; triangle large. The hind wing is very broad basally; there is a third prominent antenodal at the very base of the wing. The surface of both wings, including the costal space, is covered with a fine network of cells.

This species is close to *densus* Hagen, but is nearly twice as large and has much narrower wings. In the Carnegie collection there are two specimens of this species: No. 3829–3830 described above; and No. 3831, a complete, but poorer specimen. In the Museum of Comparative Zoölogy there is one specimen, showing the base of the two right wings and the whole of the left wings.

SUBFAMILY CYMATOPHLEBIINÆ.

Genus CYMATOPHLEBIA Deichmüller.

10. **Cymatophlebia longialata** (Germar). (Fig. 5)

Libellula longialata Germar, 1839, Nova Acta, XIX, 216; pl. 23, f. 15.
Cymatophlebia longialata Deichmüller, 1886, Mitt. Kœnigl. Mineral.-Geol. Præhist. Mus. Dresd., VII, 49; pl. 3, f. 5-8.

Length of fore wing, 70 mm.

This is a common dragon-fly, the genus being distinguished by the upward bend in R3 just below the pterostigma. The venation of *longialata* has been figured by Hagen and Deichmüller, but in neither case are the wings complete or detailed.[6] I have therefore included

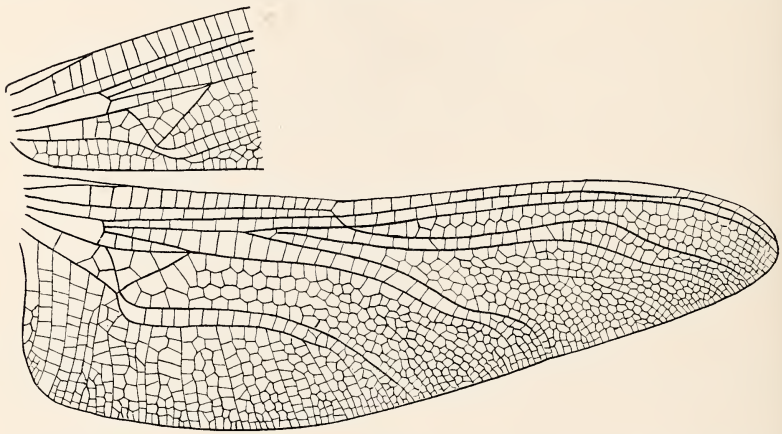

FIG. 5. *Cymatophlebia longialata* (Germar), hind wing and base of fore wing; drawn from specimens Nos. 3823–3824, Carn. Mus. Magnified.

a drawing of the hind wing and the base of the fore wing. In general structure of the wing and especially in the undulation of R3 *Cymatophlebia* is close to the *Æschninæ*; but the anal loop, characteristic

[6]Needham (1907) has figured this species in the Bulletin of the American Museum of Natural History (figure 2), based upon a specimen in the Museum of Comparative Zoölogy which he supposed to be Germar's *Æschna munsteri*. Needham established a new genus (*Morbæschna*) for this fossil, but it is of course synonymous with *Cymatophlebia*, since the specimen was really *longialata*. In the same paper he has also given a figure of what he supposed to be *longialata*, also based on a specimen in the Museum of Comparative Zoölogy; but his figure is really of a new species, described below (*jurassica*), as shown by the hind wing.

of this recent subfamily, is entirely absent. For that reason, a separate subfamily for *Cymatophlebia* is justified.

In the Carnegie Museum there are specimens of *longialata* belonging to the Bayet Collection, Nos. 3823, 3824–5103, 3825–3826, 5104, 5105, 5106, 5107, 5108, and No. 3827 received from the collection of the Paleontological Museum of Bavaria in Munich. Nos. 3823 and 3824 are excellent specimens, showing fore wings in detail. In the Museum of Comparative Zoölogy there are fourteen specimens, of which Nos. 6295 and 6248 are excellent.

11. **Cymatophlebia jurassica,** sp. nov. (Fig. 6)

Length of fore wing, 43 mm.; width 10 mm.; length of hind wing, 42 mm.; width, 14 mm.

In addition to its smaller size this species is distinguished from *longialata* by the following features: (1) the fore wing is broader in the distal half of the wing; (2) the hind wing is relatively broader throughout, and the inner margin is distinctly more rounded; and (3) in both wings and especially in the fore, the undulations of R3 are more pronounced.

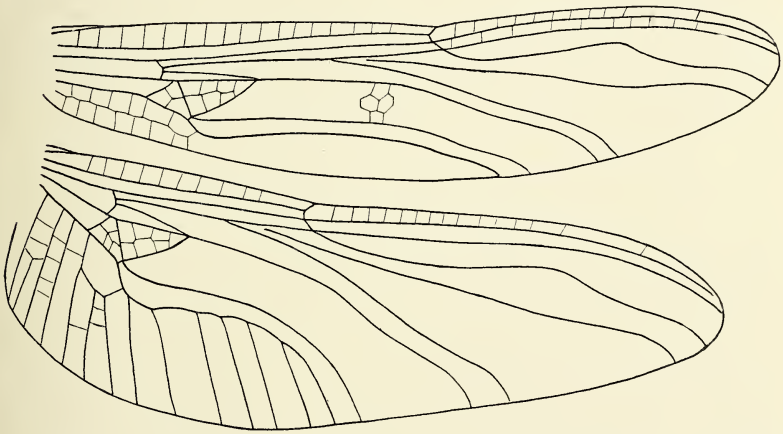

Fig. 6. *Cymatophlebia jurassica*, sp. nov., based on the holotype (No. 3819, Carn. Mus.) and the paratype (No. 6193, Mus. Comp. Zoöl.) Magnified.

Holotype: No. 3815, Carnegie Museum (Secured by Baron de Bayet) from the collection of Mrs. Gordon Thomson. This specimen

is faintly preserved, but under good illumination all the structures indicated in figure 6 are visible; the fossil shows all four wings outspread. Paratype: No. 6193 and reverse (6275) in the Museum of Comparative Zoölogy. This fossil does not show quite so much detail as the holotype, but includes all the structures essential for determination.

This is almost certainly the species represented in Needham's figure of *longialata*, based upon a specimen in the Museum of Comparative Zoölogy, although I am unable to locate in the collection the specimen which he has illustrated.

Subfamily Protolindeniinæ.

Genus Protolindenia Deichmüller.

Protolindenia Deichmüller, 1886, Mitt. Kœnigl. Mineral.-Geol. Præhist. Mus. Dresd., VII, 37.
Mesuropetala Handlirsch, 1906, Foss. Ins.: 588.

The genus *Protolindenia* was established by Deichmüller for the single species *wittei*, but new specimens of *koehleri* Hagen, the type of Handlirsch's genus *Mesuropetala*, show that this species is exceedingly close to *wittei* and should be included in the same genus. *Protolindenia* is distinguished from *Cymatophlebia* by the absence of the undulation in R3, mentioned above; in *Protolindenia* R3 and 1R2 are parallel in the region of the pterostigma.

12. **Protolindenia wittei** (Giebel).

Æschna wittei Giebel, 1860, Zitsch. Ges. Nat., XVI, 127; pl. 1, f. 1.
Protolindenia wittei Deichmüller, 1886, Mitt. Kœnigl. Mineral.-Geol. Præhist. Mus. Dresd., VII, 37; pl. 4, ff. 1, 2, 9, 10.

Length of fore wing, 40-50 mm.

This common species has been figured in detail by Deichmüller and needs no further description. The triangle of the fore wing has the top side the same length as the apical side. In the Carnegie Museum there are three specimens, Nos. 3818, 5109–5110, and 3820, the latter being the most perfectly preserved of all the Solenhofen *Odonata* which I have seen. In the Museum of Comparative Zoölogy there are twenty-one specimens.

13. **Protolindenia kœhleri** (Hagen). (Fig. 7)

Gomphus (?) *kœhleri* Hagen, 1848, Stett. Ent. Zeit., IX, 8.
Uropetala kœhleri Deichmüller, 1886, Mitt. Kœnigl. Mineral.-Geol. Præhist. Mus. Dresd., VII, 52; pl. 4, ff. 3, 11, 12.
Mesuropetala kœhleri Handlirsch, 1908, Foss. Ins. p. 588; pl. 47, f. 9.

Length of fore wing, 45-50 mm.

This species is distinguished from the previous one by having the apical side of the triangle of the fore wing much shorter than the top side. Since no complete figure of *kœhleri* has been published, I include one based on specimens No. 6194 and 1998 in the Museum of Comparative Zoölogy. There are no specimens of this species in the

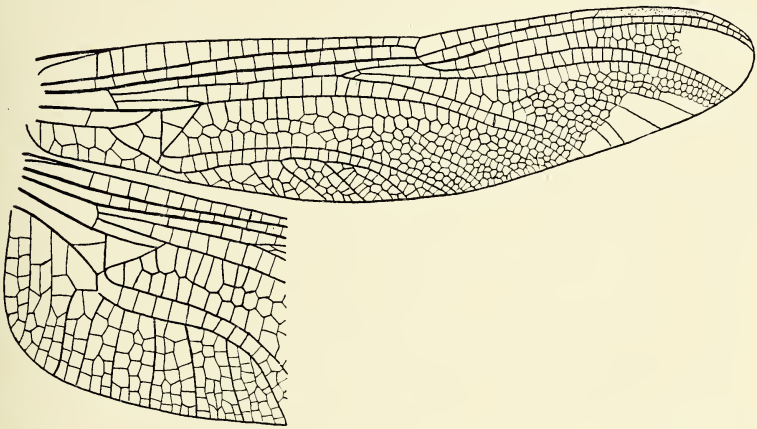

FIG. 7. *Protolindenia kœhleri* (Hagen), fore wing and base of hind wing (Specimens Nos. 6194, 1998, Mus. Comp. Zoöl.) Magnified.

Carnegie Museum. *Münsteri* (Germar), which has been doubtfully referred to *Mesuropetala*, was described only by a very crude figure showing the outlines of the wings. Specimens in Hagen's collection labelled *Æschna münsteri* are a mixture of *Cymatophlebia wittei*, and *kœhleri*. The specimen, which Needham figured as *münsteri*, and for which he established the new genus *Morbœschna* is really a *Cymatophlebia* (*longialata*) as shown by the contour of R3. *Schmideli* (Giebel), which was figured but not described by Schmidel in 1782, is also unrecognizable. I believe that both these species, *münsteri* and *schmideli*, should be dropped from the literature as unrecognizable insects.

SUBFAMILY CORDULEGASTERINÆ Calvert.

Genus ÆSCHNOGOMPHUS Handlirsch.

14. **Æschnogomphus intermedius** (Hagen). (Fig. 8)

Anax intermedius Hagen, 1848, Stett. Ent. Zeit., IX, 10.

Cordulegaster intermedius Deichmüller, 1886, Mitt. Kœnigl. Mineral.-Geol. Præhist. Mus. Dresd., VII, 45; pl. i, f. 7.

Length of fore wing, 90-95 mm.

This large species is a rare one and has only been figured by Deichmüller, who was able to represent only the main longitudinal veins. Among the specimens at my disposal there are some very fine representatives of this insect, from which I have drawn a figure of the base of the hind wing. These specimens show that the wings did not pos-

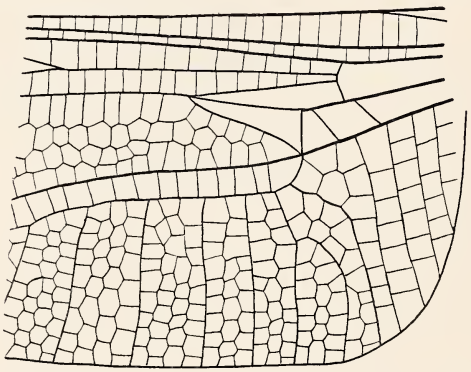

FIG. 8. *Æschnogomphus intermedius* (Hagen), base of hind wing. Drawn from specimens No. 3822 Carn. Mus. and 1997, Mus. Comp. Zoöl.

sess the anal loop characteristics of *Cordulegasterinæ*, and support Handlirsch's view that *intermedius* requires a separate genus. In the Carnegie collection there are five specimens: Nos. 3822, 3821, 5111–5112, 5113, all derived from the Bayet collection. The fifth specimen, No. 1221, was purchased at Ward's Establishment. The best of all of these specimens is No. 3822. In the Museum of Comparative Zoölogy there is one finely preserved specimen (No. 1997).

SUBFAMILY GOMPHINÆ.

Genus NANNOGOMPHUS Handlirsch.

15. **Nannogomphus bavaricus** Handlirsch.

Nannogomphus bavaricus Handlirsch, 1906, Foss. Ins., 587; pl. 47, f. 8.

Length of fore wing, 20-25 mm.

This is the smallest *Anisopteron* in the limestone; it has been completely figured by Handlirsch and I can add no details to his description. I think that there can be no doubt that *gracilis* Meunier (1896) and *nævicus* Hagen (1862) are to be referred to this species; but Handlirsch was the first to publish a recognizable description of the species and I consider that his specific name should be used. In the Carnegie collection there are three specimens, Nos. 3815, 3816, and 3817–5114. In the Museum of Comparative Zoölogy there are five specimens.

SUBORDER *ZYGOPTERA*.

The Damsel-flies of Solenhofen are very unsatisfactorily preserved; apparently the insects were too delicate to withstand decomposition long enough to become well preserved. In the collections of the Carnegie Museum and the Museum of Comparative Zoölogy there are but a few poor specimens, which can only be determined with doubt. One specimen in the Museum of Comparative Zoölogy, however, I believe to be the one figured by Needham (1903, p. 9) as an "undescribed Agrionid genus"; at least on the back of this specimen in Needham's writing are the words "Agrionid—apparently new, a fine specimen." Unfortunately, although the body and veins of this insect are well preserved, all four wings are folded together in such a manner that I am unable to produce a satisfactory figure of the fossil. If this is the specimen which Needham figured, it may be that he has correctly depicted the venation, but I am not able to follow the course of the veins, and therefore leave the species unnamed.

In the Museum of Comparative Zoölogy, in addition to the type of *Malmagrion eichstattensis* (Hagen), there is a poorly preserved fossil, which probably belongs to the same species. In the Carnegie collection there is a specimen of this insect (No. 5115) and a poorly preserved individual apparently belonging to the genus *Pseudoeupheon* (3832–3833).

Order **BLATTARIA.**

Family **MESOBLATTINIDÆ.**

Genus LITHOBLATTA Handlirsch.

16. **Lithoblatta lithophila** (Germar).

Musca lithophila Germar, 1839, Verh. L. Car. Ak., XIX, 22; pl. 23, f. 19.
Mesoblatta lithophila Scudder, 1886, Mem. Bost. Soc. N. H., III, 464.

Mesoblatta lithophila Deichmüller, 1886, Mitt. Kœnigl. Mineral.-Geol. Præhist. Mus. Dresd., VII, 6; pl. 1, ff. 1-6.
Lithoblatta lithophila Handlirsch, 1906, Foss. Ins., 530; pl. 46, f. 7.

Length of fore wing, 13-14 mm.

This is one of the commonest insects in the limestone. It has been completely figured and described by several authors. In the Carnegie collection there are seven specimens: Nos. 3791–3792, 5116–5117, 5118, 5119, 5120, 5121, 5122. In the Museum of Comparative Zoölogy there are twenty specimens. The specimens are usually preserved with the elytra outspread, as in the case of the *Coleoptera;* but they can be distinguished from the latter by the flat surface of the elytra, which are convex in the coleopterous specimens.

Order **ORTHOPTERA.**

The true *Orthoptera* represented in the formation are almost exclusively *Locustoid* types. In the Carnegie Museum there is one specimen, which I believe is undoubtedly a Grylloid; the habitus is strikingly like that of the true crickets. These have been found in the Mesozoic only in the English Jurassic, where two species have been located. It is not improbable, therefore, that this form from Solenhofen is a member of the suborder *Grylloidea*; but unfortunately neither the venation nor the structure of the body is preserved well enough to permit a definite decision.

Family ELCANIDÆ.

In the genus *Elcana* Handlirsch has recognized eight species from this one formation, although he suggests that several of the species may be synonymous. From a survey of the material at hand I believe that at most only four species are valid: *phyllophora* Handlirsch (=*bavaricus* Handlirsch, *oppenheimi* Handlirsch); *lithophila* Germar (=*amanda* Hagen, *quœrula* Weyenbergh); *deichmuelleri* Handlirsch, and *longicornis* Handlirsch. *Phyllophora* and *lithophila* are unquestionably represented in the material before me, but there are a number of specimens of *Elcana* which do not show the characteristics necessary for specific determination.

Genus ELCANA Giebel.

17. **Elcana phyllophora** Handlirsch.

Elcana phyllophora Handlirsch, 1906, Foss. Ins., 516; pl. 44, f. 1.

Length of fore wing, 22-25 mm.

Rs has 12 to 14 branches, two of which usually give rise to several short marginal veinlets. In the Carnegie collection there is one very fine specimen (No. 5123), showing the venation clearly, as well as the body and the antennæ. Another specimen is Nos. 5125–5126. In the Museum of Comparative Zoölogy there are four poorer specimens.

18. **Elcana lithophila** (Germar).

Asilicus lithophilus Germar, 1842, Münster Betrag, VIII, 87; pl. 9, f. 7.
Elcana lithophila Handlirsch, 1906, Foss. Ins., 517.

Length of fore wing, 20 mm.

Rs has 10 branches in all specimens with distinct venation. In the Carnegie Museum there is one specimen, No. 5124; and in the Museum of Comparative Zoölogy two specimens.

Family LOCUSTOPSIDÆ.

Genus CONOCEPHALITES Handlirsch.

19. **Conocephalites capito** Deichmüller.

Conocephalites capito Deichmüller, 1886, Mitt. Kœnigl. Mineral.-Geol. Præhist. Mus. Dresd., VII, 24; pl. 2, f. 2.

Length of fore wing, 40 mm.

This is a rare species, of which one specimen (No. 3781) is in the Carnegie Museum and another in the Museum of Comparative Zoölogy.

Family LOCUSTIDÆ.

Genus PYCNOPHLEBIA Deichmüller.

20. **Pycnophlebia speciosa** (Germar).

Locusta speciosa Germar, 1839, Verh. L. Car. Ak., XIX, 198; pl. 21, f. 1.
Pycnophlebia speciosa Deichmüller, 1886, Mitt. Kœnigl. Mineral.-Geol. Præhist. Mus. Dresd., VII, 20; pl. 30, f. 4.

Length of fore wing, 90-95 mm.

This large and conspicuous species is common in the limestone. It has been completely figured by Deichmüller and needs no further

description. In the Carnegie collection there are two specimens, Nos. 3783–3784 and 3793. In the Museum of Comparative Zoölogy there are nine specimens, of which one (No. 6099) is very finely preserved.

21. **Pycnophlebia minor** Handlirsch.

Pycnophlebia minor Handlirsch, 1906, Foss. Ins., 520.

Length of fore wing, 70 mm.

This is a much smaller and rarer species than the foregoing. The venation, which is well preserved in one Carnegie specimen (No. 5127) is apparently very similar (if not identical) with that of *speciosa*. There are two other specimens in the Carnegie Museum (5128, 5129) and one in the Museum of Comparative Zoölogy.

Order **PHASMODEA.**

Family CHRESMODIDÆ.

Genus CHRESMODA Germar.

22. **Chresmoda obscura** Germar.

Chresmoda obscura Germar, 1839, Verh. L. Car. Ak., XIX, 201; pl. 22, f. 4; Deichmüller, 1886, Mitt. Kœnigl. Mineral.-Geol. Præhist. Mus. Dresd., VII, 10; pl. 1, ff. 7-12. Handlirsch, 1906, Foss. Ins., 525; pl. 44, ff. 15, 19.

This striking insect caused much confusion to the older students of the lithographic insects; Germar considered one specimen to be a Mantid and another to be a Reduviid (*Hemiptera*); Oppenheim regarded it as an aquatic Homopteron, allied to the *Hydrometridæ*; and Deichmüller thought it was an Acridiid. Handlirsch, however, demonstrated conclusively that the fossil was really a Phasmid, possessing seventeen segmented antennæ and distinct cerci, as well as the wing-venation characteristic of the Phasmids. More recently Martynov has reviewed the evidence and established the suborder *Chresmododea* to include the families *Chresmodidæ*, *Necrophasmidæ* (Lias of Turkestan), *Aërophasmidæ* (Trias of Australia, and Lias of Turkestan).

Handlirsch has given a complete account of this fossil and there is little to add. Not only are the adults present (length of body 30-40 mm.), but very small immature specimens, with a body only 8 mm.

long, likewise occur. The Carnegie collection is especially rich in specimens of *obscura*, there being a total of eighteen: Nos. 3776–3777, 3778–3779, 3780, 5131–5132, 5133–5134, 5135–5136, 5137–5138, 5139, 5140, 5141, 5142, 5143, 5144–5145, 5146, 5147, 5148, 5149 are parts of the Bayet Collection; No. 3775 was received in exchange from the Paleontological Museum of Bavaria, in Munich. No. 3778 is a fine nymph. In the Museum of Comparative Zoölogy there are thirteen specimens, No. 6105 being the best I have seen.

Order **HEMIPTERA.**

Both the *Heteroptera* and the *Homoptera* are represented in the lithographic limestone. The *Heteroptera* are of unsual interest, since all the species belong to groups which were undoubtedly aquatic. as the *Belostomatidæ*, *Nepidæ*, and *Notonectidæ*. In view of this fact, and particularly in view of the abundance of the *Belostomatidæ*, it does not seem unlikely that these insects actually lived as adults in the waters that deposited the limestone, regardless of the fact that it was unquestionably saline. It is almost certain, however, that they did not breed there, but flew after the emergence of the adult from some neighboring fresh-water lake.

Family BELOSTOMATIDÆ.

Genus Mesobelostomum Haase.

23. **Mesobelostomum deperditum** (Germar)

Scarabæides deperditum Germar, Verh. L. Car. Ak., XIX, 218; pl. 23, f. 17.
Mesobelostomum deperditum Haase, 1890, N. Jahr. Mineral., II, 88.

This common species is strikingly close to the existing *Belostomum*. Most of the specimens are poorly preserved, but some show details of the wing- as well as body-structure. None of the specimens before me are exceptionally well preserved, however. There are eleven in the Carnegie Museum, of which Nos. 3843, 5150, 5151, 5152, 5153, 5154, 5155, 5156, 5210 are derived from the Bayet Collection; 3845 was obtained from the Paleontological Museum of Bavaria, in Munich, and 1219 was bought from Ward's Establishment. There are nineteen in the Museum of Comparative Zoölogy.

Family NEPIDÆ.

Genus MESONEPA Handlirsch.

24. **Mesonepa primordialis** (Germar).

Nepa primordialis Germar, 1839, Verh. L. Car. Ak., XIX, 206; pl. 22, f. 7.
Mesonepa primordialis Handlirsch, 1906, Foss. Ins., 637; pl. 51, f. 20.

This is an obscure insect, no complete specimens yet having been found. The general habitus of the body indicates that it is a relative of the recent *Nepa*. In the Carnegie Museum there are two specimens: Nos. 5157–5158, 5159–5160. There are also three in the Museum of Comparative Zoölogy.

25. **Mesonepa minor** Handlirsch.

Mesonepa minor Handlirsch, 1906, Foss. Ins., 637; pl. 51, f. 21.

Similar to the preceding insect, but much smaller. In the Carnegie Collection there are three specimens, Nos. 3842, 5161–5162, 5163–5164. In the Museum of Comparative Zoölogy there are five.

Family NOTONECTIDÆ.

Genus NOTONECTITES Handlirsch.

26. **Notonectites elterleini** (Deichmüller).

Notonecta elterleini Deichmüller, 1886, Mitt. Kœnigl. Mineral.-Geol. Præhist. Mus. Dresd., VII, 64; pl. 5, f. 67.
Notonectites elterleini Handlirsch, 1906, Foss. Ins., 639; pl. 51, f. 28.

This small Notonectid is represented by one specimen in the Museum of Comparative Zoölogy (No. 6151). Nothing is known of its general habitus.

Order **HOMOPTERA.**

Family PALÆONTINIDÆ.

Genus LIMACODITES Handlirsch.

27. **Limacodites mesozoicus** Handlirsch.

Limacodites mesozoicus Handlirsch, 1906, Foss. Ins., 622; pl. 49, ff. 12-15.

Length of fore wing, 35-40 mm.

This fossil, together with the others in the family, were placed by Handlirsch in the *Lepidoptera*, but Tillyard demonstrated (1921) that they are really *Homoptera*, allied to the recent *Cicadidæ*; and Martynov in a more recent paper (1930), based on a re-examination of

some of the type specimens from other formations, has substantiated Tillyard's conclusions. *L. mesozoicus* is represented in the Carnegie collection by one specimen (No. 5165), and in the Harvard collection by three specimens. None of them are well preserved.

Genus ARCHEPSYCHE Handlirsch.

28. **Archepsyche eichstättensis** Handlirsch.

Archepsyche eichstattensis Handlirsch, 1906, Foss. Ins., 624; pl. 50, ff. 1-2.

Length of fore wing, 25-29 mm.

In general appearance similar to the preceding, but smaller. The venation has been determined in several specimens, but is not clear in the material at hand; one specimen (No. 5166) in the Carnegie collection and two in the Museum of Comparative Zoölogy.

Genus EOCICADA Oppenheim.

29. **Eocicada microcephala** Oppenheim

Eocicada microcephala Oppenheim, 1881, Palæontogr., XXXIV, 222; pl. 31, f. 30; Handlirsch, 1906, Foss. Ins., 626; pl. 50, ff. 7-9.

Length of fore wing, 70-75 mm.

This remarkable fossil is distinguished by the short, stout body and the proportionally long wings. No specimens are in the Carnegie Museum and only one is in the Museum of Comparative Zoölogy.

Order **NEUROPTERA.**

The *Neuroptera* are not at all common in the lithographic limestone, but enough good specimens have been found to give an idea of the general composition of the fauna. Handlirsch recognizes four families, *Nymphitidæ*, *Prohemerobiidæ*, *Mesochrysopidæ*, and *Killigrammidæ*. Specimens of each of these groups except the *Killigrammidæ*, which is known from a single specimen, are present in the collections placed before me for study.

Family NYMPHITIDÆ.

Genus MESONYMPHES Carpenter.

30. **Mesonymphes hageni** Carpenter.

Mesonymphes hageni Carpenter, Psyche, 1929, pp. 35, 190; f. 1.

Length of fore wing, 40 mm.

The type specimen (No. 1999) is in the Museum of Comparative Zoölogy.

Family PROHEMEROBIIDÆ.

Genus OSMYLITES Haase.

31. **Osmylites protogæus** (Hagen).

Chrysopa protogæus Hagen, 1862, Palæontogr., X, 108.
Osmylites protogæus Haase, 1890, N. Jahr. Mineral., II, 22; f. 10.

Length of fore wing, 25-28 mm.

One of the smallest of the *Neuroptera* from Solenhofen, this obscure species is represented in the Carnegie Museum by one specimen (Nos. 5167–5168), and another in the Museum of Comparative Zoölogy. The venation is only partially known, and in neither of these specimens can I discern any features additional to those already described.

Genus ARCHEGETES Handlirsch.

32. **Archegetes neuropterorum** Handlirsch.

Archegetes neuropterorum Handlirsch, 1906, p. 605; pl. 48, ff. 1-2.

Length of fore wing, 70-75 mm.

In the Museum of Comparative Zoölogy there is one specimen, very close to the one described by Handlirsch, but a little smaller.

Genus GIGANTOTERMES Haase.

33. **Gigantotermes excelsus** (Hagen).

Apochrysa excelsus Hagen, 1862, Palæontogr., X, 108.
Gigantotermes excelsus Haase, 1890, N. Jahr. Mineral., II, 12.

Length of fore wing, 52-59 mm.

One specimen (No. 5169) in the Carnegie Museum. All four wings are preserved, but only the faintest traces of the venation.

Family MESOCHRYSOPIDÆ Handlirsch.

Genus MESOTERMES Haase.

34. **Mesotermes heros** (Hagen).

Termes heros Hagen, 1862, Palæontogr., X, 114; pl. 15, f. 1.
Mesotermes heros Haase, 1890, N. Jahr. Mineral., II, 13.

Length of fore wing, 45-48 mm.

The type specimen (No. 1996) is in the Museum of Comparative Zoölogy, as well as another specimen, which is well preserved. The

venation in the latter is very clear and demonstrates that *heros* is a *Mesochrysopid*, as Handlirsch suspected. The species is so close to *Mesochrysopa zitteli* Meunier, differing only in size, that the two species undoubtedly belong to the same genus. However, if this view is taken, then the appropriate generic name *Mesochrysopa* will become *Mesotermes* and the family *Mesotermitidæ*, which is very misleading. For this reason, I suggest that regardless of the close affinities of *heros* and *zitteli*, the generic separation be retained.

NEUROPTERA, incertæ sedis.

35. "**Corydalis**" **vetusta** Oppenheim. (Fig. 9)

Corydalis vetusta Hagen, 1862 (not described), Palæontogr., X.—Oppenheim, 1888, Palæontogr., XXXIV, pl. 30, f. 3; pl. 31, f. 31.—Meunier, 1898, Arch. Mus. Teyler, II, (6); pl. 18, ff. 50-51.

Length of fore wing, 40 mm.

This obscure insect has been known by several specimens, which showed the general habitus of the body only, including a large elongate head. Handlirsch suggests that the insect is a Sialid or a Perlid. In the Carnegie Museum there is one well preserved specimen (No. 3846), showing the wings as well as the characteristic body. Unfortunately, however, only a portion of the fore wing is clear enough

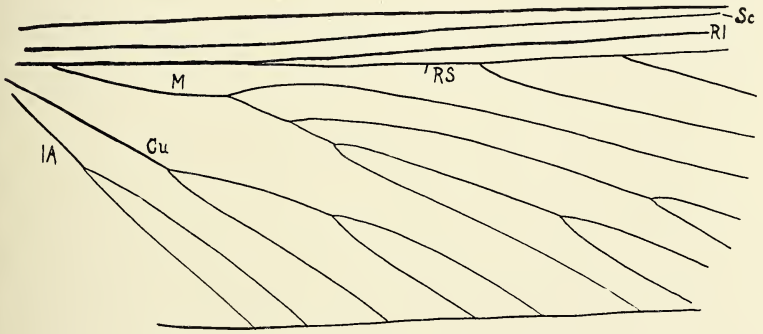

FIG. 9. "*Corydelis*" *vetusta* Hagen, part of fore wing (Specimen No. 3846 Carn. Mus.)

so that the veins can be distinguished. Enough is preserved, I believe, to show that the insect is a *Neuropteron*, probably one of the *Megaloptera*; the two parallel branches of Rs, which is parallel to R1, are certainly more characteristic of the *Neuroptera* than of the Perlids.

However, since the apex of the wing is missing, it is impossible to state with certainty just to what family of *Neuroptera* this fossil is most closely related.

Order **COLEOPTERA.**

The *Coleoptera* of the lithographic limestone are the most unsatisfactory of all the insects in the formation. Nearly always the whole insect is preserved with the elytra outspread, but with the hind wing folded up or twisted in such a manner that the venation is not decipherable. This condition and the absence of taxonomic characteristics in the elytra alone prevent us from determining even the family position with any degree of certainty. The most that can be said is that beetles were common in the vicinity of the water, which deposited the limestone; and that a diversity of forms existed. Handlirsch recognizes forty species, but I believe that many of these are synonymous.

In the Carnegie Museum and the Museum of Comparative Zoölogy the following species are prèsent:* *Pyrochroophana brevipes* Deichmüller (5170), *Ditomorptera dubia* Germar (3785–3786), *D. minor* Deichmüller (3794–5172, 5171, 5173, 5174, 5175), *Sphærodermopsis jurassica* Oppenheim (3847, 5176–5177), *Actea sphinx* Germar (3790, 3795, 5178–5179, 5180, 5181, 5182), *Malmelater costeri* Weyenbergh (5183, 5184), *Pseudohydrophilus avitus* Heyden (3788, 5185–5186), and *Procalosoma major* Handlirsch (3787).

Order **TRICHOPTERA.**

Specimens representing this order are extremely rare in the lithographic shales. In none of these has the venation been so distinct that a satisfactory concept of the wing could be reached, and there is a possibility that the fossils belong to the allied order *Paratrichoptera*, which is amply represented in the Jurassic of Turkestan. The only specimen of *Trichoptera* from Solenhofen, which I have seen is probably *Archotaullus bavaricus* Handlirsch (No. 5187), in the Carnegie Museum. The complete insect is preserved, even the long antennæ; but none of the veins can be distinguished.

*The numbers following the names are those representing specimens in the Bayet Collection.

Order HYMENOPTERA.

Family PSEUDOSIRICIDÆ.

Genus PSEUDOSIREX Weyenbergh. (Fig. 10)

The *Hymenoptera* of Solenhofen, although apparently belonging to a single genus and very few species, are perhaps the most important of all the insects in the formation. Until the discovery of *Hymenoptera* in the Jurassic of Turkestan in 1927, these specimens have been almost the sole representatives of the order in the Mesozoic. Most of the fossils show only the general habitus of the wings and body, but these are so characteristic of the siricoid wasps that even the older students of fossil insects recognized them as belonging to that group. Even poorly preserved specimens show the stout ovipositor of the female very plainly, and good specimens possess the numerous wrinkles in the distal part of the wings, typical of the siricoid wasps.

The members of this genus are common in the limestone and, like the recent siricids, are highly variable in size; as a consequence, fourteen species have been described, based largely on differences in dimensions. Handlirsch lists all of these as distinct species, but suggests that some are synonyms. In the material before me there are forty-six specimens of *Pseudosirex*, and from my study of them I am led to believe that there are only two valid species: *nanus* Handlirsch and *schroeteri* (Germar) (genotype), which includes all the other species. *Nanus* is distinguished by its very small size, the fore wing being only 25 mm. long. *Schroeteri*, as I consider it, has a length of wing which varies from 30-60 mm., most specimens being about 40 mm. In the collections at hand there is a series with a complete gradation in sizes between these extremes. The smaller specimens are probably males, and the larger females. It is even possible that *nanus* is a small male of *schroeteri*, for there is no apparent difference in venation. *Schroeteri* is represented in the Carnegie collection by eleven specimens (Nos. 3799–3800, 3805–3806, 3809, 3810–5199, 5200–5201, 5202–5203, 5204–5205, 5206, 5207, 5208, 5209), and in the Museum of Comparative Zoölogy by thirty-one specimens. Specimen No. 3810 in the Carnegie Museum is unusually well preserved, showing all but the distal parts of the veins. *Nanus* is represented in the Carnegie Museum by several poor specimens and one other (No. 5189), which I believe is the best specimen of *Pseudosirex* that has been found; the two fore wings and the body are preserved, the wings being outstretched

on each side. The Carnegie Museum also lists Nos. 3803–3804, 5188, 5189, 5190–5191, 5192–5193, 5194–5195, 5196, 5197, 5198, 3801–3802.

In spite of the abundance of specimens of *Pseudosirex* the venation has been hitherto more or less uncertain. Figures of the wings given by Deichmüller, Oppenheim, Weyenbergh, and Handlirsch were very generalized, only the heaviest veins being indicated. Tillyard has published a complete analysis of the venation of the wings (1927), based upon specimens in the Paleontological Museum at Münich, although he states that in none of these specimens could the veins be made out with absolute accuracy, owing to the wrinkles in the distal half of the membrane. In the specimen of *nanus* in the Carnegie

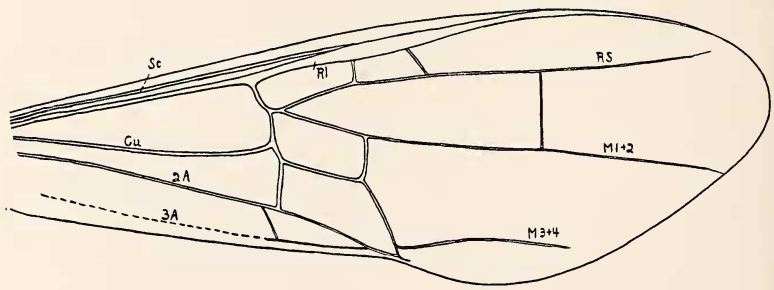

FIG. 10. *Pseudosirex nanus* Handlirsch, fore wing; specimen No. 5189, Carnegie Museum. For convenience I have used the venational nomenclature suggested by Bradley ("Guide to the Wings of Insects"), without, however, intending to imply a complete acceptance of this interpretation.

Museum, as well as in the above mentioned specimen of *schroeteri*, the veins are exceptionally clear; in the former specimen they are preserved as brown or yellow-brown lines, instead of being merely ridges or grooves. In figure 10 I have reproduced a detailed drawing of the fore wing of this fossil, in which I have included only the structures which are clear enough to be positive. There may be additional crossveins between Rs and M1+2, or M1+2 and M3+4 in the distal part of the wing, but I can see no traces of them in the fossil.

It will readily be noted that there are numerous differences between the venation as I have represented it, and as it was figured by Tillyard. An enumeration of these differences is hardly necessary, but they comprise such important features as the position of Sc with respect to R, the point of termination of Sc, the position of the pterostigma, the

number of branches in Rs, and the point of termination of Cu1, 2A, and 3A; as well as minor characters, such as the shape of the wing and the cells. These discrepancies are far too great to be due to individual variation, but there remain two possible explanations: either the specimens which Tillyard figured belong to an entirely different species (or genus) than those which I have studied; or they were not well enough preserved to enable him to determine accurately the course of the veins. I think that there can be no question that the specimens, upon which I have worked, are the true *Pseudosirex*; the venation in the specimen of *schroeteri* is precisely the same as that in the specimen of *nanus*, so far as it can be distinguished; so that if Tillyard's specimens were as he believed them to be, they probably belong to a different genus.

This Carnegie specimen of *nanus* enables us to characterize the family *Pseudosirex* more definitely than before: the costal space is narrow, the subcosta being very close to the radius, almost contiguous to it; Sc terminates on R1 in the region of the pterostigma; the pterostigma is well developed, R1 being swollen and thickened, and the costal space being chitinized at this point; M diverges from R1 almost at right angles, instead of being directed basally as in the recent Siricoids; two cross-veins are present between Rs and R1, in the region of the pterostigma; 3A is slightly removed from the posterior margin and fuses apically with Cu1+Cu2.

The venation of *Pseudosirex* seems to approach that of *Xeris* much more closely than that of any of the other recent genera.[7] If we bear in mind that in the distal part of the fossil wing there may be one or two cross-veins, which I have not been able to see, the similarity to *Xeris* is very striking (Figure 11). M in *Pseudosirex* is more primi-

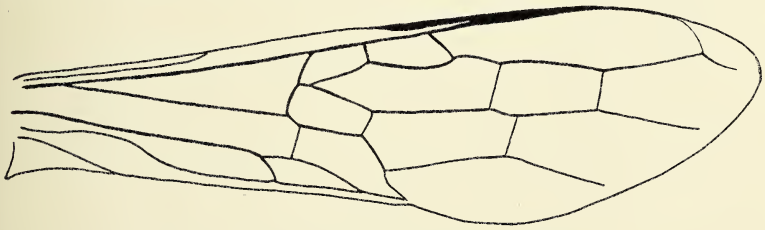

FIG. 11. Fore wing of *Xeris caxdatus* (original).

[7] I am indebted to Professor C. T. Brues for furnishing me with specimens of *Siricidæ* for comparison with *Pseudosirex*.

tive in its origin and perhaps 3A is also; but the venation is remarkably modern for a Jurassic species, especially for one which is the oldest record of the *Hymenoptera*.

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